Border is better than distance?
Contagious corruption in one belt one road economies

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Abstract

Employing data of one belt one road (OBOR) countries from 2002 to 2013, this study compares the contagious corruption difference between geographic border and distance through the dynamic spatial econometric model. The empirical results not only confirm that corruption in OBOR countries exists under various contagious channels, but also indicate that border effects, serving as contagious channels for corruption, are better than distance effects. The empirical implication is that OBOR countries with a common border tend to possess contagious corruption due to the hosts' demonstration effect and the convenience of transferring illegal assets. We advise that those OBOR countries should enhance the supervision of cash flow, look for any opportunity of kicking back a portion of the stolen money, and establish a specific task force on corruption.

Key Words: Contagious Corruption, Border and Distance Effect, Spatial Channels, One Belt One Road

JEL codes: C33 D73 P25

1 Introduction

The existing literature proves that if neighboring countries have similar patterns of political culture, then they can affect the host corruption by controlling the countries' economic level (Becker et al., 2009). Frequent economic trade and similar political institutions are also confirmed as corruption contagion channels in previous literature, leaving the aspects of geographic border and distance unexplored (Sui et al., 2017). Scholars have investigated the spatial corruption phenomenon and contagious corruption, yet most of them ignore the spatial matrix computational methods of corruption; in fact, only a few studies in the literature have looked at the difference between border and distance contagious channel. Therefore, this research uses the data of one belt one road countries over the period 2002-2013 and utilizes spatial econometrics as well as the panel generalized method of moments (GMM) model to compare the different contagious channels of corruption from a spatial perspective.

For the above purposes, after confirming the spatial phenomenon via spatial autocorrelation, we first establish spatial economic analysis of corruption using GMM, seeking the reliable instrumental variables approach to resolve the endogeneity that is correlated with the key independent variable, but uncorrelated with the error term. Second, we employ different spatial panel GMM models, including a border geographic matrix as well as a distance geographic matrix, after controlling the host economic and institutional variables. Third, we contribute to a comparison between the border geographic channel and the distance geographic channel, which are mostly overlooked by the existing literature. This comparison is of great significance for the different potential contagious channels by not only determining the optimal potential computational method of the spatial corruption matrix, but also offering effective anti-corruption measures for policy makers. In the final step, we focus on a special region - namely, the one belt one road (OBOR) countries. Here, the worse level of corruption control is convenient for comparing different geographic contagious channels of corruption and for analyzing the issue from a new economic organizational perspective. As a rising international economic collaboration platform, this region's control of corruption is noteworthy for academia and policymaking bodies.

The reason for investigating the different spatial geographic channels of corruption in OBOR is rather important. First, host corruption has a demonstration effect on neighboring countries that have borders with each other (Accinelli and

Sanchez 2012). Countries with common borders always have similar economic, political, and cultural characteristics (Becker et al., 2009). Second, in order to protect the handling of illegal domestic assets, local officials typically prefer transferring them to nearby areas, and such transfers lead to contagious corruption (Attila, 2008), especially for these OBOR countries that are particularly vulnerable to corruption. Third, as frequent commercial intercourse facilitates contacts among government officials and businessmen of multinational corporations, globalization is accelerating cross-country corruption. Countries with no shared borders may have contagious corruption with each other. Fourth, corrupt behavior disperses via intensive business contacts (Kaymak and Bektas, 2015) and international organizations (Becker et al., 2009). Thus, the spatial distance matrix represents rather well the contagious corruption level for countries that have no border with each other.

Reviewing the previous literature, scholars have presented the relationships between corruption and economic growth (Dong and Torgler, 2010). The mechanisms that host corruption influences economic growth are called “helping hand” and “grabbing hand”, which work based on reducing transaction costs and increasing rent seeking, respectively (Bliss and di Tella, 1997; Aidt, 2003; Lopez and Mitra, 2000). Some research scholars also consider corruption as the main factor impacting innovation, environment, and the capital market. In this respect, Lau et al. (2013) provide empirical evidence that real innovation activities have been hindered by the effect of bribery on patent applications, implying the “grabbing hand” effect is present through the mechanism of corruption on innovation activities. Chang and Hao (2017) argue that higher corruption in non-OECD countries decreases the quality of government, while a host country with abundant environmental performance makes it convenient for creating harmful impacts upon economic growth. Lau et al. (2013) utilize firm-level data analysis to investigate the beneficial influence of corruption on the stock market. Furthermore, the relationship between globalization and corruption has been confirmed by some scholars; Lalountas et al. (2011) find that globalization has various impacts on corruption for countries with different income levels. Bojnec (2017) utilizes OECD data, revealing a significant positive association pertaining to corruption and the host country’s economic globalization.

Academia has also shown the linkage between host corruption and nearby corruption on the basis of the argument that neighboring countries exhibit an imitation behavior for contagious corruption (Rosa et al., 2010). Previous literature on corruption has revealed the mechanisms through which host corruption leads to decreased competition for corporations (Celentani and Ganuza, 2002; Wilson and Damania, 2005), especially for developing countries with lower economic development and unstable state power. In fact, corruption plays different roles in economic development through the host political power. For instance, Khan (1998) reveals the different influences of corruption on an economy by comparing different patron-client networks in Asian countries. Talvitie (2017) analyzes the industrial organization of corruption in Asia and proposes that the rise of the 'economic miracle' in Asia is due to corruption and rent-seeking; for instance, the chaebols of South Korea and back door of China. The regional economic miracle is characterized by inadequate an institutional framework, systemic corruption, and crony capitalism. The OBOR countries are almost all located in Asia, and the above characteristics are distinctly observed.

The topic of developing countries' corruption usually concerns the control of corruption. Studies use a professional corruption index (Corruption Perception Index) and individual-level survey data to analyze the relationship between corruption and governance (Javaid, 2010; Tavits, 2010; Satpayev, 2014). The results reflect that poor governance leads to bribery, and that the optimal method for controlling corruption is to improve the capacity for strong governance (Mahmood, 2010). Table 1 lists some studies on the topic of corruption control in OBOR, covering, for instance, Poland, Croatia, Singapore, Mongolia, and others. Satpayev (2014) comparatively analyzes the influence of low governance quality of developing countries, revealing that corruption is the main reason for their low governance quality. Nguyen et al. (2012) utilize micro-enterprise data to investigate the relationship between corruption and growth for private firms in Vietnam. Riley and Roy (2016) find that India's corruption on the system of business licensing is clearly present from the 1950s to 1980s. Thus far, few scholars in the previous literature have analyzed the contagious corruption phenomenon of OBOR countries.

Although the existence of the contagious corruption phenomenon has been confirmed through the spatial econometric model (Becker et al., 2009; Attila, 2008; Sui et al., 2017), the existing literature is still debating what are the “neighbors”. For instance, Anselin (2003) defines neighbors based on the concept of whether they share a common border. Border countries always have the same historical background and similar culture transmission. Research on economic growth, population growth, and innovation typically uses a border as the neighbor channel. Porter (1996) focuses on the issue of whether knowledge exchanges afforded by border proximity can foster regional competitiveness. Firmino Costa et al. (2017) use the border definition as the Brazilian population growth spillover channel to analyze urban and rural population growth over the period 1970-2010. With globalization and the rapid development of new information and communication technologies, others argue that the economy, culture, and politics among countries eventually become similar. Countries with no borders have played a key role in the world - for instance, the United States, China, and so on (Conley and Ligon, 2002). Some scholars prefer using distance to define neighbors in globalization related research. Furthermore, Stern and Van Dijk (2017) analyze global particulate pollution concentrations through the spatial distance matrix of the world.[1]

The above existing literature suffers from three problems that cast doubt on the previous conclusions. First, few scholars define geographic border corruption and distance corruption in terms of neighbors. Moreover, there is a lack of concern about what is an optimal neighbor in corruption research, with geographic border and distance having different influences with various corruption contagion channels. Thus, seeking the best contagious corruption channel between geographic border and distance is meaningful in the field of political economy. Second, the traditional literature mainly targets the relationship between host governance and corruption in

[1] Few political economists are concerned about the definition of neighbor in their research on corruption. Anselin (2003), Becker et al. (2009), and Márquezet et al. (2011) define the average corruption value as neighbors’ corruption, which is the sum of the corruption values of neighbors sharing a common border, and this sum is then divided by the number of neighbors. In addition, Attila (2008) expands the defintion of neighbors through geographic distance in order to better represent contagious corruption.

OBOR, with few choosing OBOR corruption data to investigate the optimal contagious channel. As OBOR is a rising regional organization, the control of corruption there is an important issue that OBOR should be confronting. Determining the effective anti-corruption contagious channel is essential for both academic and political bodies. Overall, the empirical results in this paper illustrate the optimal contagious corruption channel in OBOR, in which the geographic contagious channel of a border is stronger than those distance one.

The rest of this paper proceeds as follows. Section 2 briefly introduces the tests of spatial autocorrelation, the measure of spatial weights, as well as the dynamic panel GMM approach. Section 3 reports the estimation results from OBOR countries. Finally, section 4 offers some policy implications.

2 Econometric methodology and model

2.1 The spatial autocorrelation tests

Before employing the spatial econometric model, it is essential to investigate global spatial autocorrelation if the space dependence of corruption is significant. Thus, we utilize the *Moran* index, *Geary index*, and *Getis-Ord* index to test whether the space dependence of corruption is significant. The *Moran* index is expressed as:

$$Y = \mu + X\beta + \rho WY + \varepsilon , \tag{1}$$

where Y denotes a $N \times 1$ vector of dependent variables, X denotes a $N \times N$ matrix of independent variables, β represents the coefficient vector of *X*, *W* represents the adjacency-related weight, and ε is a remainder disturbance term that is independently normally distributed. We assume the null hypothesis, $H_0 : \rho = 0$, which means the space dependence of corruption is insignificant and the model is shown in model (2); otherwise, $H_1 : \rho \neq 0$, which means spatial autocorrelation is confirmed.

$$Y = \mu + X\beta + \varepsilon . \tag{2}$$

The Moran index is calculated as:

$$I = \frac{N}{S} \times \frac{\varepsilon^{'} W \varepsilon}{\varepsilon^{'} \varepsilon}, \tag{3}$$

where *S* represents the sum of elements in the spatial matrix *W*, and *N* is the dimensionality of variables. If *W* is a standardized matrix, then *S*=*N*, and the Moran index is normally distributed. The Moran index ranges from -1 to 1; a positive Moran index reveals positive spatial autocorrelation; and vice versa if the calculated value is negative; a Moran index equal to zero reveals that spatial autocorrelation is not significant. The mean and variance of Moran statistics are normally distributed as:

$$E(\mathrm{I}) = \frac{N}{S} \frac{tr(\mathrm{MW})}{S(\mathrm{N-K})}, \tag{4}$$

where *W* represents the spatial-weighted matrix, and *N* represents the number of cross-countries; it is noteworthy that *M* is the mapping matrix ($M = I_N - X(\mathrm{X}^{'}\mathrm{X})^{-1}\mathrm{X}^{'}$), thus establishing Moran's statistic.

We use another spatial autocorrelation, named the *Getis-Ord* index (Getis and Ord, 1992), and establish the distance (between the capitals of countries i and j) spatial matrix:

$$Getis-Ord(d) = \frac{\sum\sum w_{ij}(d) x_i x_j}{\sum\sum x_i x_j}, \tag{5}$$

where x_i and x_j correspond to the sample countries of *i* and *j*, and w_{ij} is the spatial matrix. Comparing the *Getis-Ord* index and its expected value, it is notable that if the index statistics are larger than the expected value, then there is high spatial agglomeration and vice versa.

We also adopt the *Geary index* as an alternative spatial autocorrelation index:

$$Geary(C) = \frac{(n-1)\sum\sum w_{ij}(x_i - x_j)^2}{2\sum\sum(x_i - \bar{x})^2}, \tag{6}$$

where x_i and x_j represent the sample observations of *i* and *j*, and w_{ij} is the element of the spatial matrix. The calculated value represents positive spatial autocorrelation, while the *Geary index* is smaller than one if the calculated value is larger than one, and vice versa; moreover, the insignificant autocorrelation reveals the calculated value is equal to one. The Geary index is also normally distributed with a range of [0, 2].

2.2 The measurement of the spatial-weighted matrix

We should choose suitable spatial weights after investigating if the spatial autocorrelation of corruption does exist. The different results of the spatial model are caused by introducing different weighted matrices (Pinkse and Slade, 1998; Lesage, 2000 and Plümper, 2010). We employ the adjacency-related definition, namely border (Becker et al., 2009; Márquezet et al., 2011). If a country has a common geographic border with others, then the elements of the spatial-weighted matrix are equalt o 1; otherwise, 0. If a country has a common border with n countries, then nearby countries' elements of the geographic spatial-weighted matrix are defined as $w_{ij}^{G} = 1/n$, where n is the number of border neighboring countries. The spatial-weighted matrix of N countries is a symmetric matrix that includes elements of 0 ($N \times N$) in the leading diagonal. The geographic-weighted matrix reveals whether the contagious corruption phenomenon exists through a border. A country that has multiple borders with others has a relatively higher probability of being affected by contagious corruption.[2]

We employ a border-weighted matrix to measure the contagious corruption effect among OBOR countries.[3] In order to think over other geographic contagious channels and avoid rows being assigned with all zeros, we employ the geographic distance-weighted matrix (Becker et al., 2009; Ertur and Koch, 2007; Mayer and Zignago, 2011; Goel and Saunoris, 2014).[4] According to Goel and Saunoris (2014), the geographic distance-weighted matrix is defined as $w_{ij}^{D} = 1/d_{ij}$, where d_{ij} is the geographic distance from country capital *i* to country capital *j*, and W_{jt}^{D} reveals the

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[2] In order to define the geographic-weighted matrix, we choose land borders rather than maritime borders. Thus, we have to abandon some island countries.

[3] Anselin (1990) argues for delineating a specified circle area that defines a certain distance as the radius of a circle, which is the rough measure of the spatial-weighted matrix.

[4] Reviewing the political economic perspective, contagious corruption is possible in the spatial economy. Researchers summarize the institutional characteristics of geographic infection, including democracy (Brinks and Coppedge, 2001), liberty (Simmons and Elkins, 2004), and policy choice (Meseguer, 2006). Inter-communication in the World Bank and OECD accelerates corruption infection (Márquezet et al., 2011; Becker et al., 2009; Attila, 2008). However, our topic concerns what is an optimal neighbor from the geographic perspective; thus, we focus on which is a better contagious channel between border and distance.

geographic distance-weighted matrix.[5]

2.3 Panel-GMM model

The traditional literature utilizes the instrument variables (IV) dealing with the problem of endogeneity (Ghonghadze and Lux, 2016), and the GMM method also provides a reliable IV variable in corruption research (Sekrafi and Sghaier, 2016). Since we consider obtaining consistent estimates in the presence of the contagious corruption effect in OBOR countries, for purposely dealing with problem of endogeneity, the generalized method of moments (GMM) should be utilized (Goel and Saunoris, 2014), because it is deemed as a convenient approach to avoid variables' endogeneity, while the traditional approach usually is combined with the estimated bias (Fischer et al., 2009; Dettori et al., 2012).

Following the theory constructed by Goel and Saunoris (2014) and Becker et al. (2009), we use the panel-GMM model analyzing the contagious effect of corruption in OBOR countries:

$$\mathrm{Corruption}_{\mathrm{it}} = \alpha + \rho \sum_{i=1}^{N} W_{\mathrm{jt}} \mathrm{Corruption}_{\mathrm{jt}} + \sigma \mathrm{Corruption}_{\mathrm{it-1}} + \sum_{i=1}^{\mathrm{m}} \beta_{\mathrm{i}} \mathrm{X}_{\mathrm{it}} + \varepsilon_{\mathrm{it}} . \qquad (7)$$

Here, $Corruption_{it}$ denotes the host corruption of country *i* in period *t*, ρ denotes the spatial lag parameter of the host corruption infected by nearby countries, $\sum_{i=1}^{N} W_{\mathrm{jt}} \mathrm{Corruption}_{\mathrm{jt}}$ reveals the spatial influence of host corruption infected by neighboring countries, X_{it} denotes a control variables matrix, containing institutional and economic factors, etc., and ε_{it} is remainder disturbance term that is independently normally distributed. The matrix formulation is transformed as equation (7):

$$\mathrm{Corruption}_{\mathrm{Nt}} = \alpha + \rho W \mathrm{Corruption}_{\mathrm{Nt-1}} + \sigma \mathrm{Corruption}^{*}_{Nt-1} + \mathrm{X}_{\mathrm{Nt}} \beta + \varepsilon_{\mathrm{Nt}} , \qquad (8)$$

[5] In line with the viewpoint of Goel and Saunoris (2014), distance is a spherical distance, calculated by the longitude and latitude of the capitals in the OBOR countries.

$$Corruption_{Nt} = \begin{bmatrix} Corruption_{1t} \\ Corruption_{2t} \\ \vdots \\ Corruption_{Nt} \end{bmatrix}_{N\times 1}, \quad \alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_N \end{bmatrix}_{N\times 1},$$

$$Corruption^* = \begin{bmatrix} Corruption_{1t-1} \\ Corruption_{2t-1} \\ \vdots \\ Corruption_{Nt-1} \end{bmatrix}_{N\times 1}, \quad W = \begin{bmatrix} w_{11} & w_{21} & \cdots & w_{1N} \\ w_{12} & w_{22} & \cdots & w_{2N} \\ \vdots & \vdots & \vdots & \vdots \\ w_{N1} & w_{N2} & \cdots & w_{NN} \end{bmatrix}_{N\times N}$$

It is noteworthy that $WCorruption_{\text{Nt-1}}$ denotes a $N \times 1$ vector of the host countries' corruption as infected by neighboring countries, $\text{Corruption}^*_{Nt-1}$ represents a $N \times 1$ vector of host corruption at time *t-1*, X denotes a matrix of control factors, and β represents the coefficient matrix of control factors.

$$X = \begin{bmatrix} x_{11} & x_{21} & \cdots & x_{1m} \\ x_{12} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ x_{N1} & x_{N2} & \cdots & x_{Nm} \end{bmatrix}_{N\times m}, \quad \beta = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_m \end{bmatrix}_{m\times 1}$$

Based on these explanations, we define W^B_{jt} and W^D_{jt} as the spatial weights, revealing the various spatial weights for different spatial descriptions.

We first introduce a geographic border.

$$\text{Corruption}_{\text{it}} = \alpha + \rho\sum_{i=1}^{N} W^B_{jt}\text{Corruption}_{\text{jt}} + \sigma\text{Corruption}_{\text{it}-1} + \sum_{i=1}^{\text{m}}\beta_{\text{i}}\text{X}_{\text{it}} + \varepsilon_{\text{it}} \qquad (9)$$

$$\text{Geographic border weighted matrix } W^B_{jt} = \begin{bmatrix} 0 & w^b_{12} & \cdots & w^b_{1N} \\ w^b_{21} & 0 & \cdots & w^b_{2N} \\ \vdots & \vdots & \vdots & \vdots \\ w^b_{N1} & w^b_{N2} & \cdots & 0 \end{bmatrix}_{N\times N}$$

Here, W^B_{jt} reflects whether there is a common border between the host country and nearby countries. We then consider introducing the spatial-weighted matrix of geographic distance as follows:

$$\text{Corruption}_{\text{it}} = \alpha + \rho'\sum_{i=1}^{N} W^D_{jt}\text{Corruption}_{\text{jt}} + \sigma'\text{Corruption}_{\text{it}-1} + \sum_{i=1}^{\text{m}}\beta'_{i}\text{X}_{\text{it}} + \varepsilon_{\text{it}} \qquad (10)$$

The set-ups of W_{jt}^{D} are similar to W_{jt}^{B}.

3 Empirical results

3.1 Data and variables

The data of 33 countries (shown in Figure 3) over the period 2002-2013 are mainly collected from both World Development Indicators (WDI) and Worldwide Governance Indicators (WGI). The main variable in our empirical model is the index control of corruption (*Corruption*), whereby corruption offers a chance for bureaucrats utilizing public power to take private gains. The range of index control of corruption is [-2.5, 2.5]. In addition, we build two potential geographic channels to detect whether the contagious corruption phenomenon exists in the OBOR countries. We consider the geographic border ($W_{jt}^{B}Corruption$) channel and the geographic distance ($W_{jt}^{D}Corruption$) channel. This paper also considers choosing other factors of corruption for eliminating omitted variable bias.

According to previous literature, economic development and political institution may contribute to the level of corruption, and we thus include the following economic variables in our estimated models: (1) gross domestic product (GDP) per capita (*Real GDP per Capita*), revealing that high-level income may increase corruption (Paldam, 2002; Treisman, 2000; Scott, 1969; Tanzi, 2000; Orttung, 2006). The strict size of a state matters for leading corruption, because lower levels of bureaucratic quality bring about more chances for the appearance of contagious corruption in a society (Mbaku, 1996; Orttung, 2006); (2) trade openness (*Trade openness*), reflecting that a competitive market (in a perfectly competitive market), namely the level of openness, leads to lower corruption (Wei, 2000; Ades and Di Tella, 1996, 1999); (3) exports of minerals and fuel (*Rent*), revealing that abundant rents generate opportunities for the occurrence of rent-seeking activity, and the rent-seeking activity is associated with a high corruption level (Fearon and Laitin, 2003; Collier and Hoeffler, 2005).

In line with the viewpoint of Becker (1968) and Rose-Akerman (1996), the consciousness of corruption can be expressed as a variable of the integrity of a municipality and its citizens. We employ a variable, which is used in the field of political economy, to reveal institutional features and to define corruption as an indicator of political power (Yeyati et al., 2010). Higher political power creates a motive for rent-seeking behavior by government officials and enhances the probability for corruption.

We thus consider to introduce four institutional variables to reflect the social and political landscapes of host corruption, consisting of voice and accountability (*Voice and Accountability*, which reflects the rights of private citizens for free elections and to unionize), rule of law (*Rule of Law*, which captures the consciousness of a law governing nation), government effectiveness (*Government Effectiveness*, which captures the sense of the quality of public services), and regime durability (*Durable*, which captures the stability since the most recent regime succession).[6,7] The range of institutional variables is [-2.5, 2.5], and they are collected from WGI of the World Bank, while *Durable* data are collected from the Polity IV dataset. In addition, we also consider the globalization variable in the model to check for the influence of host corruption. Based on the research of Attila (2008) and Becker et al. (2009), globalization acts as a bridge for the contagion of corruption across OBOR countries.

Table 2 shows the descriptive summary of variables in OBOR countries; the mean of *Corruption* is -0.281, which is bigger than the world average of corruption (-0.086) and reflects that OBOR countries possibly face serious regional corruption. The means of three institutional variables (*Rule of Law*, *Government Effectiveness*, and *Voice and Accountability*) are all less than zero, implying that institutional quality of OBOR countries still has large room for improvement. For the remaining control factors, such as *Real GDP per Capita*, *Trade Openness*, and *Rent*, the means are 6576.716, 91.989, and 10.604, respectively. The mean of *Globalization* is 50.412,

[6] The theory is ambiguous on how these factors influence national corruption (La Palombara, 1994; Rose-Ackerman, 1997; Huntington, 1996).

[7] Regime durability (*Durable*) might lead to changes in the level of national corruption. In calculating the *Durable* value, the first year during which a new (post-change) polity is established is coded as the baseline “year zero” (value = 0), and each subsequent year adds one to the value of the *Durable* variable consecutively until a new regime change or transition period occurs.

implying that OBOR countries have relative higher host globalization level.

3.2 Spatial autocorrelation test

Table 3 reports the tests for spatial autocorrelation, including both *Moran index*, *Geary index*, and *Getis-Ord* index, by utilizing the control of the corruption variable. The *Moran index* is expressed in equation (3); the *Getis-Ord* index, which uses the variable control of the corruption variable, is expressed in equation (5); and *Geary index* is expressed in equation (6). As assumed, all coefficients of the *Moran index*, *Geary index*, and *Getis-Ord index* are almost significantly positive at the 5% level, reflecting that there exists the contagious corruption phenomenon in OBOR countries. The corruption interaction within this region is the obvious reason for the high corruption level. The range of *Moran index* autocorrelation coefficients is [0.188, 0.380], the range of *Geary index* autocorrelation coefficients is [0.519, 0.744], while the *Getis-Ord index* ranges from 0.112 to 0.176. The *Moran index* and *Getis-Ord index* present a similar trend. When using different equations for calculation, the *Geary index* and *Moran index* present an opposite trend. The *Moran index* gets its maximum at 2005 and then fluctuates just like the *Getis-Ord index* fluctuation trend. The situations of *Moran index*, *Geary index*, and *Getis-Ord* index represent that the control of corruption level among OBOR countries has increased over the whole trend, and the mean control of corruption level still shows a serious situation.

We then use the diagrams of Moran (Anselin, 2003) to prove the spatial correlation of corruption among the OBOR countries.[8] The diagram of Moran is a scatter diagram of regional corruption and host corruption from the cross-countries' perspective, where host corruption points at the X-axis and regional corruption points at the Y-axis. The numerical Moran index is expressed through an adjustment line (average relationship). The positive autocorrelation expresses that the OBOR countries have like standards in quadrants I and III; the negative autocorrelation expresses that the OBOR countries have like standards in quadrants II and IV. Figures 1-3 clearly describe a positive correlation between host corruption and neighboring

[8] We use diagrams of Moran from the 33 OBOR countries, and Table 4 contains the countries' full name and abbreviation.

countries for 2002, 2005, and 2013. These figures reveal that the contagious corruption phenomenon exists and that the accompanying grouping of OBOR countries leads to higher corruption levels (quadrant III).

3.3 The contagion of corruption channel

Common borders influence the more extensive value of the contagion of corruption channel, and therefore we intend to solve any concerns through the dynamic panel GMM approach. For the purpose of comparison, we investigate the contagion of corruption phenomenon via borders in Table 4,[9] where columns 1-6 present the results of the panel GMM model, and column 7 reflects the fixed effects regression on contagious corruption in OBOR countries. All models reveal a better fit in that the F-test and Wald-test are significant in columns 1-7, and the model selection diagnostic criteria are in accordance with AIC and SC. Table 4 reveals the results of the F-test and Wald-test in the fourth and fifth lines from the bottom. The bottom of Table 4 shows the spatial panel autocorrelation tests, and these results represent that the economic model has spatial autocorrelation (Global Moran MI, Global Geary GC, and LM Lag tests). The variable $Corruption_{it-1}$ has a positive effect at the 5% level, offering evidence that the corruption of OBOR countries is persistent. The positive coefficient of $Corruption_{it-1}$ reflects a dynamic corruption model where the lagged corruption level influences both current and former corruption levels. The higher corruption levels of OBOR countries in the future will dependent on a way to maintain the current and former corruption levels. The former control of corruption continue affecting the host corruption in the anticipate perspective (Herzfeld and Weiss, 2003).

We hence discuss the effect of geographic border, where the positive and statistically significant coefficient of $W_{jt}^{B}Corruption$ strongly indicates that the consciousness of host corruption is influenced by nearby countries' corruption, which is estimated by the geographic spatial-weighted matrix of borders. This shows clear

[9] It is worth noting that apart from spatial-weighted matrix l corruption, all the variables in any econometric specification are defined at the national single country level.

evidence that the contagious corruption phenomenon is confirmed through the geographic spatial-weighted matrix of borders, in which $W_{jt}^{B}Corruption$ represents a positive influence on the host control of corruption at the 5% significant level. It confirms the spread of corruption and infection from nearby countries, as the estimated results support the hypothesis that the host corruption is infected by nearby countries via the geographic border channel; for instance, transmigration, international trade, or civil interactivity (Rahim et al., 2013). It is noteworthy that there is an obvious difference between the fixed effects model and panel-GMM regression. Just like the Sekrafi and Sghaier (2016) empirical results, the $W_{jt}^{D}Corruption$ of the panel-GMM regression offers an unbiased estimated value versus the static regression.

For the other factors of corruption, the connections among institutional variables, consisting of *Voice and Accountability*, *Rule of Law*, and so on, are still debatable. It is noteworthy that *Durable* is not significant at the 10% level in OBOR countries. As shown in columns 2 and 6, other institutional factors have a positive effect on host corruption at the 5% significant level. These above results are in accordance with Abdih et al. (2012), who support that transparent institutions raise the control of corruption. There is more evidence of the different institutional variables bringing about various effects on corruption in OBOR countries, as shown in columns 3 and 6; *Voice and Accountability* and *Government Effectiveness* possess obvious significant effects on corruption after controlling for the geographic contagious channel.

We next consider the economic factors of corruption. It is noteworthy that *Rents* in column 4 has a negative effect at the 5% significant level, proving that abundant rent-seeking behavior increases the host corruption. Introducing all control factors in column 5, the empirical results are mostly in accordance with previous literature except for *Real GDP per Capita*, which reflects the negative effect at the 5% significant level.[10] The empirical result of *Trade Openness* is in accordance with

[10] Although the previous literature argues that higher *GDP per capita* usually leads to lower corruption, developed countries may not have lower corruption. The various factors of corruption from economy, politics, and society are the main reason. We also discover that all OECD countries are located in

foregoing research, which advises that the host corruption in the receiving countries is conducted through a reduction of FDI (foreign direct investment) (Larrain and Tavares, 2004). It is noteworthy that the effect of *Trade Openness* is tiny and *Trade Openness* is necessary for the level of corruption, revealing that trade exchanges among OBOR countries may be insufficient. Furthermore, the results in column (6) indicate the negative effect of globalization on the control of corruption at the 10% significant level, indicating a higher degree of globalization brings about a lower level of corruption (Akhter, 2004).

We now investigate the contagion of the corruption effect through geographic distance. As shown in Table 5, all models reveal a better fit in that the F-test and Wald-test are significant in columns 1-6, and the model selection diagnostic criteria are in accordance with AIC and SC. Table 5 reflects the estimation results of the Wald-test and F-test at the fourth and fifth lines from the bottom. The bottom of Table 5 shows the spatial panel autocorrelation tests, and the results indicate that the economic model has spatial autocorrelation (Global Moran MI, Global Geary GC, and LM Lag tests). The positive coefficient of the variable $Corruption_{it-1}$ indicates that country corruption has been anticipated through past levels, which is in line with the finding of Herzfeld and Weiss (2003).

We therefore discuss the effect of geographic distance, where the statistically significant coefficient of $W_{jt}^{D}Corruption$ strongly supports the hypothesis that the host corruption is influenced by nearby countries' corruption, as estimated by the geographic spatial-weighted matrix of distance. The positive coefficient of $W_{jt}^{D}Corruption$ represents that geographic distance channels of corruption do exist, and that theit effect gradually decreases with an increase in distance. The estimated results point out that the consciousness of host corruption is infected by nearby countries through the geographic distance channel; for instance, international trade or international organizations' interaction (Kaymak and Bektas, 2015). Considering

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quadrant I in the scatter diagram of spatial autocorrelation, meaning some developed countries have higher corruption in the real world.

other factors of corruption, the connections among institutional factors, including *Voice and Accountability* and *Rule of Law*, are still debatable. Similar to what is shown in Table 4, there is an obvious difference between static regression and panel-GMM regression in Table 5. Although the institutional variables have positive impacts significantly at the 5% level, *Voice and Accountability* especially plays a major role in the effect on corruption after controlling for the geographic contagious channel. The empirical results reflect that greater rights of citizens for free elections and unions in OBOR countries effectively increase control over the corruption level. The variables of economic impacts are not significant at the 10% level, demonstrating that the economic variables are not the primary factors. Hence, column (6) again indicates the negative effect of globalization at the 10% significant level, reflecting a higher degree of globalization leads to a lower level of corruption.

In Table 4 we find that the corruption contagious effect of the geographic border channel is larger than the geographic distance channel. The coefficient of $W_{jt}^{B}Corruption$ is larger than $W_{jt}^{D}Corruption$ after controlling for the consistent variables of corruption. According to the argument of Accinelli and Sanchez (2012), host corruption has a demonstration effect on neighboring countries that share a border with each other. Countries with a common border always have similar economic, political, and cultural characteristics, and thus host corruption prefers to spread to countries on the border. In addition, the empirical results observed from the OBOR data support the view of Attila (2008) in that transitions lead to contagious corruption, which means local officials prefer to transfer their illegal assets to nearby areas (Attila, 2008). Above all, the empirical results represent that the border channel is better than the distance channel, and that the literature should use geographic border as the definition for neighbor in corruption research.

4. Conclusion

This research utilizes spatial econometrics to compare different potential contagious channels in OBOR countries over the period 2002-2013. The empirical results reveal that corruption autocorrelation does exist among these countries using the *Moran index* and other forms of analysis, while the diagrams of the Moran scatter clearly describe a positive relation among OBOR countries. Furthermore, we use both the dynamic panel GMM approach and fixed effects model for estimating the corruption contagion effects and comparing these effects under the potential contagious channel. After comparing these channels, we see that contagious corruption does exist frequently through border neighbor countries versus other channels in OBOR countries. Finally, the host demonstration effect and transfer of illegal assets across countries through borders are the potential reasons for such a distinct contagious channel of corruption through borders.

In line with the empirical results, we offer several policy implications as follows. First, our results support that the corruption of OBOR countries exhibits the contagious effect, revealing that anti-corruption is not just the duty of a particular country, but also an action required through cooperative governance from a regional angle. Therefore, policymakers should pay more attention on the proximity corruption via the border. These findings herein advise that governments should raise international collaboration for the purpose of preventing contagion from nearby corruption. Finally, multiple geographic contagious channels imply that government officials among OBOR countries should pay attention to both border and distance, especially the geographic border channel.

We provide these findings of OBOR countries for scholars who are interested in this field. This evidence can help establish a government cooperation mechanism through Internet technology that provides anti-corruption networks among OBOR countries. It is also essential for all countries to enhance public consciousness, preserve and raise press freedom, enhance investigation into corruption, and utilize modern information technology to raise control over the corruption level (Hacek et al., 2013). Referring to the studies of Becker et al. (2009) and Attila (2008), neighboring countries should enhance the supervision of cash flow and look for any opportunity of kicking back a portion of the stolen money. In addition, a specific task force on corruption across the nearby countries in OBOR should be established to deal with the contagious corruption phenomenon through borders.

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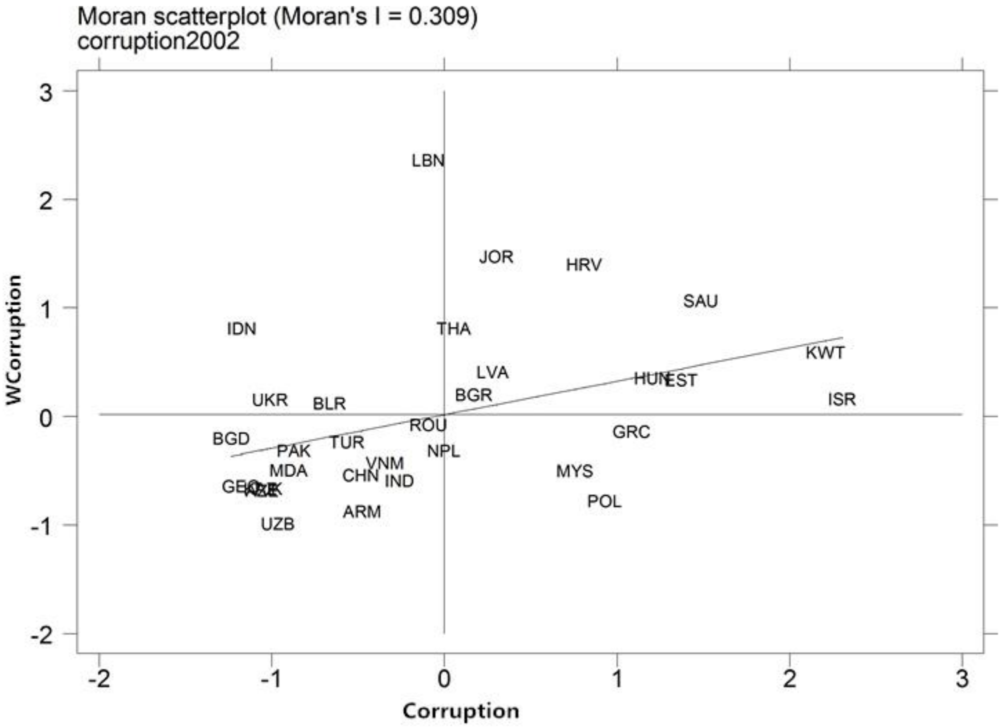

Figure 1: 2002 Diagrams of Moran

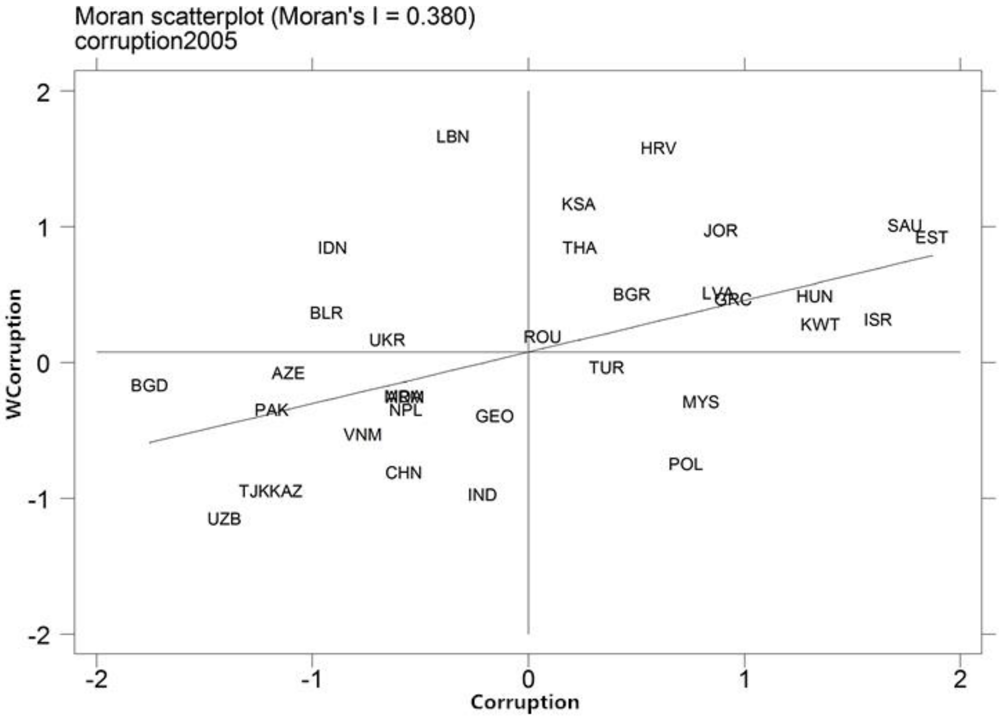

Figure 2: 2005 Diagrams of Moran

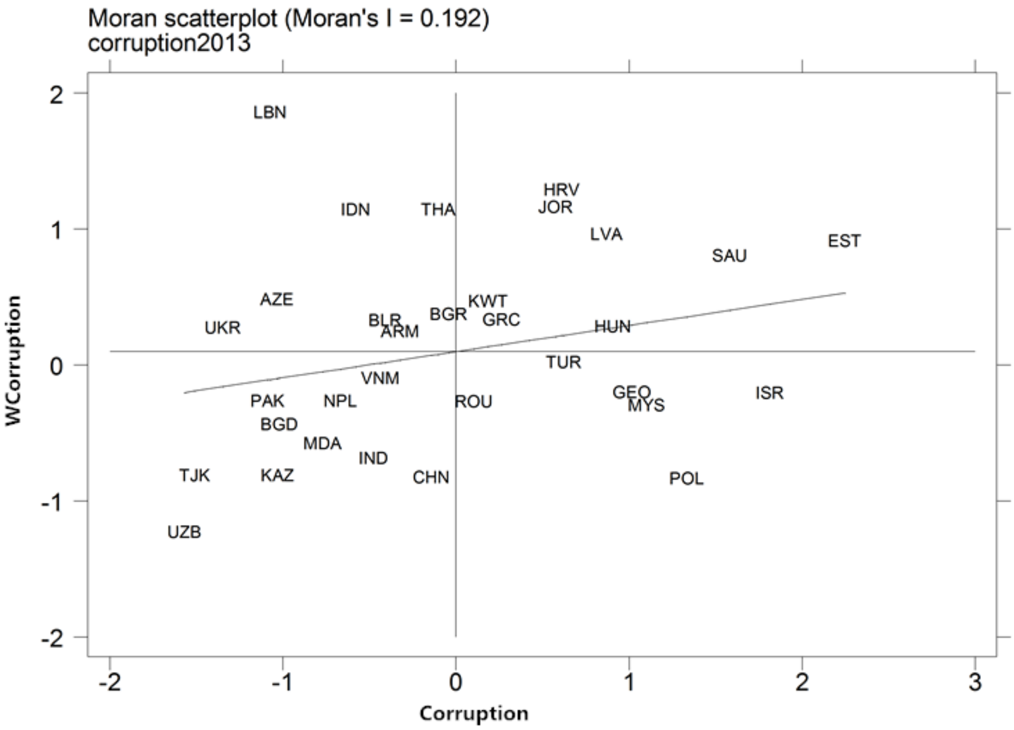

Figure 3: 2013 Diagrams of Moran

Note: The countries' full name and abbreviation proceed as follows: Armenia (ARM), Azerbaijan (AZE), Bangladesh (BGD), Belarus (BLR), Bulgaria (BGR), China (CHN), Croatia (HRV), Estonia (EST), Georgia (GEO), Greece (GRC), Hungary (HUN), India (IND), Indonesia (IDN), Israel (ISR), Jordan (JOR), Kazakhstan (KAZ), Kuwait (KWT), Latvia (LVA), Lebanon (LBN), Malaysia (MYS), Moldova (MDA), Nepal (NPL), Pakistan (PAK), Poland (POL), Romania (ROU), Saudi Arabia (KSA), Slovenia (SAU), Tajikistan (TJK), Thailand (THA), Turkey (TUR), and Ukraine (UKR).

Table 1 Literature of corruption in OBOR countries

Author(s)	Sample countries	Period	Method	Research contents
Quah (2001)	Six countries in Asia	2001	Case study	Three patterns of anti-corruption.
McManus-Czubińska et al. (2004)	Poland	2001	Case study	Influence of corruption.
Rock and Bonnett, (2004)	East Asian countries	1980-1996	OLS regression	East Asian corruption and economic growth in a comparative politics perspective.
Budak (2006)	Croatia	2002-2004	Comparative analysis	Anti-corruption policy measures of Croatia.
Wallace and Latcheva (2006)	Central and Eastern European post-communist countries	1998	Questionnaire	Corruption and trust in public institutions.
Azfar and Gurgur (2008)	Philippines	2008	OLS regression and Probit regression	Corruption on health and education outcomes in the Philippines.
Javaid (2010)	Pakistan	1996-2009	Case study	The relationship between governance and corruption.
Tavits (2010)	Estonia	2004	Questionnaire	Individual-level determinants of corruption.
Mahmood (2010)	Bangladesh	1999-2010	Case study	Anti-corruption.
Siddiquee (2010)	Malaysia	1995-2008	Questionnaire	The critical overview of the anti-corruption strategies in Malaysia.
Rose and Mishler (2010)	Russia	2007	Questionnaire	Individual perception and experience of paying bribes.
Nguyen et al. (2012)	Vietnam	2005	OLS regression	Corruption, growth, and public governance.
Batory (2012)	Central Eastern Europe countries	2012	Comparative analysis	Law and anti-corruption in Central Eastern Europe countries.
Glüpker (2013)	Croatia and Macedonia	2004-2007	Case study	Minority rights and anti-corruption policies.
Hacek et al. (2013)	Slovenia	2002-2011	Questionnaire	Corruption and trust in political and administrative institutions.
Satpayev (2014)	Developing countries	1999-2011	Comparative analysis	Influence of low governance quality.

Kapeli (2015)	Malaysia	1995-2014	Questionnaire	Anti-Corruption Initiatives in Malaysia.
Katsios (2015)	Greece	1999-2003	Case study	Underground economy and corruption
Roy (2016)	India	1947-1991	Case study	Privatization, kindred phenomena, and corruption in India.
Sidorkin and Vorobyev (2017)	Russia	2005-2012	Panel logit regression	Political cycles and corruption in Russian regions.

Table 2 Descriptive analysis

Variable	Obs.	Mean	Std. Dev.	Min	Max
Corruption	396	-0.281	0.625	-1.488	1.292
Rule of Law	396	-0.144	0.681	-1.441	1.164
Government Effectiveness	396	-0.028	0.661	-1.261	1.367
Voice and Accountability	396	-0.300	0.891	-2.098	1.157
Real GDP per Capita	396	6576.716	7515.739	276.291	36356.650
Trade Openness	396	91.989	38.382	26.858	210.373
Rents	396	10.604	17.769	0.002	89.220
Durable	396	20.646	19.502	0.000	87.000
Globalization	396	50.412	28.592	0	87.290

Notes: *Corruption* reflects the extent of perception in which public power is exercised for private gain. GDP per capita (*Real GDP per Capita*) reflects a higher level of income may increase corruption. Trade openness (*Trade openness*) reveals a competitive market. Exports of minerals and fuel (*Rent*) imply that abundant rents may create opportunities for rent-seeking behavior, and the rent-seeking behavior is associateed with a high corruption level. *Voice and Accountability* captures citizens' right to free elections and association. *Rule of Law* reflects the extent of perceptions. *Government Effectiveness* reflects perceptions of the quality of public services. *Durable* means the number of years since the most recent regime change. *Globalization* means the level in which a country participates in trend of globalization.

Table 3 Test for spatial autocorrelation: 2002-2013

		Border						*Distance*	
Year	*Moran's I*	*Z*	*p*	*Geary'C*	*Z*	*p*	*Getis-Ord*	*Z*	*p*
2002	*0.309*	*2.080a*	*0.019*	*0.623*	*-2.155a*	*0.016*	*0.112*	*2.701a*	*0.003*
2003	*0.192*	*1.361b*	*0.087*	*0.657*	*-2.000a*	*0.023*	*0.123*	*2.888a*	*0.002*
2004	*0.291*	*1.952a*	*0.025*	*0.602*	*-2.333a*	*0.010*	*0.146*	*3.314a*	*0.000*
2005	*0.380*	*2.495a*	*0.006*	*0.519*	*-2.823a*	*0.002*	*0.176*	*3.881a*	*0.000*
2006	*0.192*	*1.358b*	*0.087*	*0.698*	*-1.745a*	*0.041*	*0.128*	*2.898a*	*0.001*
2007	*0.276*	*1.865a*	*0.031*	*0.646*	*-2.063a*	*0.020*	*0.140*	*3.199a*	*0.001*
2008	*0.269*	*1.862a*	*0.034*	*0.635*	*-2.124a*	*0.017*	*0.149*	*3.374a*	*0.000*
2009	*0.278*	*1.891a*	*0.029*	*0.631*	*-2.126a*	*0.017*	*0.144*	*3.292a*	*0.000*
2010	*0.281*	*1.899a*	*0.029*	*0.633*	*-2.140a*	*0.016*	*0.140*	*3.211a*	*0.001*
2011	*0.251*	*1.720a*	*0.043*	*0.664*	*-1.942a*	*0.026*	*0.155*	*3.51a*	*0.000*
2012	*0.188*	*1.334b*	*0.091*	*0.744*	*-1.478b*	*0.070*	*0.130*	*3.039a*	*0.001*
2013	*0.192*	*1.361b*	*0.087*	*0.742*	*-1.494b*	*0.068*	*0.121*	*2.853a*	*0.002*

Notes: [a] and [b] indicate statistical significance at the 5% and 10% levels, respectively.

Table 4 Geographic border channel of contagious corruption

Variables/Models	(1)	(2)	(3)	(4)	(5)	**(6)**	(7)
W^{B}_{jt}*Corruption*	0.133^{a}	0.132^{a}	0.132^{a}	0.130^{a}	0.130^{a}	0.129^{a}	0.166^{a}
	(4.60)	(4.88)	(4.58)	(4.51)	(4.82)	(4.87)	(2.62)
$Corruption_{it-1}$	0.862^{a}	0.786^{a}	0.864^{a}	0.882^{a}	0.815^{a}	0.834^{a}	
	(8.31)	(10.32)	(8.26)	(8.26)	(9.51)	(10.01)	
Rule of Law		0.246^{a}			0.220^{a}	0.221^{a}	0.449^{a}
		(3.21)			(2.82)	(2.85)	(6.18)
Government effectiveness		0.254^{a}			0.253^{a}	0.250^{a}	0.343^{a}
		(4.04)			(4.01)	(3.96)	(5.40)
Voice and Accountability		0.258^{a}			0.253^{a}	0.255^{a}	0.308^{a}
		(3.94)			(3.84)	(3.85)	(5.69)
Durable			1.081		0.001	0.001	-0.008^{a}
			(0.28)		(0.48)	(0.53)	(-4.33)
Real GDP per Capita				0.045	0.077	0.045	0.082
				(0.28)	(0.48)	(0.40)	(1.45)
Trade Openness				0.002	0.001	0.001	0.001
				(0.21)	(0.02)	(0.25)	(1.51)
Rents				-0.002^{a}	0.002^{a}	0.002^{a}	0.001
				(-2.37)	(2.09)	(2.00)	(0.35)
Globalization						-0.006^{b}	-0.001
						(-1.89)	(-0.17)
Constant	-0.024^{a}	-0.016^{a}	-0.034^{a}	-0.070^{a}	-0.143^{a}	-0.020	-0.627^{a}
	(-3.77)	(-2.13)	(-2.91)	(-0.44)	(-0.67)	(-0.46)	(-1.65)
F	45.150^{a}	37.438^{a}	30.214^{a}	19.225^{a}	19.457^{a}	18.575^{a}	29.46
Wald Test	90.299	187.187	90.641	19.225	175.115	185.749	89.254
AIC	0.013	0.014	0.014	0.014	0.016	0.015	-
SC	0.014	0.016	0.015	0.015	0.018	0.017	-
Global Moran MI	0.027	0.122	0.038	0.066	0.173	0.106	-
Global Geary GC	0.897	0.848	0.892	0.871	0.808	0.843	-
LM Lag	4.774	6.804	5.315	4.724	5.252	5.538	-

Notes: ^{a} and ^{b} indicate statistical significance at the 5% and 10% levels, respectively. AIC and SC indicate panel model selection diagnostic criteria, seeking the optimal model through a lower calculated value after controlling enough variables. Global Moran MI, Global Geary GC, and LM Lag indicate spatial panel autocorrelation tests. If the calculated value is larger than the critical value, then the original hypothesis is rejected. Columns 1-6 show the estimations of panel GMM model while column 7 provides the results of fixed effects regression.

Table 5 Geographic distance channel of contagious corruption

Variables/Models	(1)	(2)	(3)	(4)	(5)	(6)	(7)
W^{D}_{jt} *Corruption*	0.047[a]	0.053[a]	0.046[a]	0.045[a]	0.051[a]	0.062[a]	0.102[a]
	(3.70)	(4.45)	(3.63)	(3.57)	(4.28)	(4.87)	(4.40)
Corruption$_{it-1}$	0.908[a]	0.840[a]	0.913[a]	0.927[a]	0.865[a]	0.908[a]	
	(8.81)	(11.25)	(8.84)	(8.81)	(10.41)	(8.65)	
Rule of Law		0.227[a]			0.205[a]	0.190[a]	0.455[a]
		(2.94)			(2.62)	(2.15)	(6.36)
Government Effectiveness		0.228[a]			0.229[a]	0.264[a]	0.326[a]
		(3.57)			(3.57)	(3.66)	(5.24)
Voice and Accountability		0.314[a]			0.307[a]	0.404[a]	0.313[a]
		(4.64)			(4.51)	(5.56)	(5.89)
Durable			0.003		0.001	0.006	-0.007[a]
			(1.09)		(0.35)	(0.02)	(-4.20)
Real GDP per Capita				0.041	0.068	-0.020	0.063
				(0.25)	(0.30)	(-0.12)	(1.13)
Trade Openness				0.003	0.002	0.008	0.001
				(0.50)	(0.30)	(1.06)	(1.00)
Rents				0.002[a]	0.002[b]	0.003[b]	-0.001
				(2.24)	(1.92)	(1.93)	(-0.70)
Globalization						-0.006[b]	-0.001
						(-1.91)	(-0.09)
Constant	-0.010	0.003	-0.017[b]	-0.038	-0.085	-0.054	-0.352
	(-1.39)	(0.33)	(-1.7)	(-0.37)	(-0.50)	(-0.44)	(-0.93)
F	45.612[a]	39.926[a]	31.008[a]	19.483[a]	20.583[a]	15.965[a]	31.84
Wald Test	91.222	199.631	93.024	97.415	185.242	159.664	75.622
AIC	0.013	0.015	0.014	0.014	0.016	0.017	-
SC	0.014	0.016	0.015	0.015	0.018	0.019	-
Global Moran MI	0.018	0.022	0.001	0.028	0.032	0.058	-
Global Geary GC	0.992	0.985	1.013	0.982	0.972	0.825	-
LM Lag	2.123	2.775	0.318	3.156	4.181	4.173	-

Notes: Same as Table 4.